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Taxonomic status of the ant *Lasius nipponensis* Forel, 1912 (Hymenoptera, Formicidae)

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Abstract. — Morphological and biochemical comparisons are held on among the European to East Asian populations of *Lasius fuliginosus* (Latreille). Those are divided into two populations : European, Caucasian and Asia Minor populations, and Far East Russian, Japanese and Korean populations. Head proportions and body pilosity and pubescence in the workers and queens –longer and more developed in East Asian population– allow for a specific separation of both populations. Major components of mandibular gland secretion also differed : both populations have dendrolasin as a major component but only East Asian population contained 3-formyl-7,11-dimethyl-(2E,6Z,10)-dodecatrienal. It is proposed to change the name to be applied to East Asian population, formerly known under the name *Lasius fuliginosus* (Latreille), and reinstate the name *Lasius nipponensis* Forel as a good species. The name *Lasius fuliginosus* var. *orientalis* Karavaiev should be considered a junior synonym of *L. nipponensis*.

Résumé. — Nous proposons de restaurer le nom *Lasius nipponensis* Forel, comme une bonne espèce. Ce nom doit s'appliquer aux populations asiatiques, connues auparavant sous le nom de *Lasius fuliginosus* (Latreille). Les proportions céphaliques, pilosité du corps, et pubescence chez les reines et ouvrières permettent une séparation des deux espèces. La composition de la sécrétion des glandes mandibulaires diffère aussi : bien que la dendrolasine est présente dans les deux espèces, *L. nipponensis* montre la présence d'une forte proportion de 3-formyl-7, 11-dimethyl-(2E, 6Z, 10)-dodecatrienal. Le nom *Lasius fuliginosus* var. *orientalis* Karavaiev doit être considéré un synonyme de *L. nipponensis*.

Key words. — Hymenoptera, Formicidae, Taxonomy, *Lasius nipponensis*, stat. rev., *Lasius fuliginosus*, mandibular gland.

INTRODUCTION

In 1912 Forel proposed a new name *nipponensis* as a variety of *Lasius fuliginosus* (Latreille) for a sample of ants from Tokio (Tokyo). Differential characteristics as compared with European *L. fuliginosus* were its smaller body size, thinner petiole, narrower head in workers and longer and denser pubescence on the alitrunk and gaster in queens.

SANTSCHI (1941) raised this variety to specific status by merely stating «La tête est un peu plus large que chez *fuliginosus* ...» and without any other justification. In his comprehensive monograph of the genus *Lasius*, WILSON (1955) commented on the geographic variation of *Lasius fuliginosus*, and mentioned a sample of queens from Odawara, Japan, that fitted well with Forel's comments on pubescence, adding that «A case may be made in the future for according this form specific status» ; but he went not further as «the associated workers and males are *hardly* (ours italic) separable by themselves from the typical *fuliginosus*». WILSON (1955) designated a lectotype for the var. *nipponensis* ; that lectotype showed the long pilosity of petiolar dorsal margin, «characteristic of the Japanese populations already described». He proposed formally the synonymy of var. *nipponensis* Forel under the species *L. fuliginosus* (Latreille). YAMAUCHI & HAYASHIDA (1968) retained that synonymy, and YAMAUCHI (1979) in a much informative paper, with careful measurements and indices, did not add to the state of the question and that name has been consistently used by Japanese authors. The name of *L. fuliginosus* is currently used in the Web page of Japanese ants (http://ant.edb.miyakyo-u.ac.jp/HTMLS/INDEX.HTM) although, interestingly, Onoyama (1980) expressed the view that the synonymy proposed by WILSON (1955) «might be erroneous». We concur. In 1990, KUPYANSKAYA published a useful revision of subgenus *Dendrolasius* from the Soviet Far East, still using the name *L. fuliginosus* for all those populations. The same name has been applied to North Korean samples (COLLINGWOOD, 1976, 1981). *Lasius fuliginosus* var. *orientalis* described by Karavaiev (1912) from Korea was provisionally synonymized with *L. fuliginosus* by WILSON (1955).

A recent exchange of *L. fuliginosus* samples among the authors permitted a thorough comparison of populations from Europe and its surrounding area and East Asia. We have confirmed morphological differences and feel necessary of a reassesment of taxonomic treatment. Some of those differences were yet noted by Forel in his original description of the var. *nipponensis*. Here we propose to resurrect the name *nipponensis* and to accord specific status — as *L. nipponensis* Forel — to East Asian and Far East European populations.

MATERIAL AND METHODS

Specimens examined : the following specimens were examined for this study. Numbers in parentheses show those of workers, and of nests respectively. Croazia : Plitvice, 27-VII-1985, Romero leg. (2,1). France : Dieppe (Seine Maritime), Grouvelle (4,1) ; Sayat (Puy de Dôme) (6,1) ; Garches (Hauts de Seine), V-1916 (6,1). Italy : Emilia, Spilamberto, Minozzi leg. (7,1). Emilia, 21-VI-1903, Fiori leg. (2,1). Japan : Kyoto University (Kyoto Pref.), 6-X-1998, Akino leg. (10,1) ; Tsukuba (Ibaraki Pref.), 6-VII-1998, 27.8.1998 and 21-V-2000, Akino leg. (95,10) ; Mito (Ibaraki Pref.), 16-IX-1998, Akino leg. (10,1) ; Nakano-ku (Tokyo), 26-VIII-2000, Kubota leg. (10,2). Korea : Inch'ŏn, 18-VIII-1990, Terayama leg. (2,1) ; Mt. Paektusan (North Korea), 2000 (no collecting day and month in a label), Choi leg. (2, 1). Russia : Sakhalin, 20-VII-1978, Kupyanskaya leg. (3,1). Spain : Arrazola (Navarra), 20-VII-1995, Espadaler leg. (10,1) ;

Bolvir (Girona), 12.VII.2000, Espadaler leg. (10,1) ; Castiello de Jaca (Huesca), 14-IX-1978, Espadaler leg. (10, 1) ; Ger (Girona), 20-VI-1973, Espadaler leg. (9,1) ; Lles (Girona), 1992, 10-XI-1998, Espadaler leg. (20,2) ; Meranges (Girona), 10-XI-1998, Espadaler leg. (10,1) ; Taull (Lleida), 9-VIII-1974, Espadaler leg. (10,1) ; Peredilla (León), 8-VI-1983, Espadaler leg. (4,1). Yugoslavia : Belgrade, 8-IV-1988, Montull leg. (2,1). Sexuals have been available in a few samples. France : Ostwald (Bas Rhin), 30-V-1981, Muñoz leg. (one queen). Germany : Berlin, 30-VIII-1984, Escolà leg. (one male). Italy : Trento, Poldi leg. (one queen, one male). Japan : Tsukuba (Ibaraki Pref.), 21-V-2000, Akino leg. (60 males and 40 queens from two nests). Spain : Oza (Huesca), 25-VII-1979, Mas leg. (3 queens) ; San Juan de la Peña (Huesca), 26-VII-1977, Pedrocchi leg. (one queen) ; Plà Traver, Falgars (Girona), 12-VIII-1985, Suñer leg. (3 males) ; Villasrubias (Salamanca), 17-VII-1983. Lizana leg. (one queen).

Measurements and indices : head width (HW) : maximum width of the head excluding eyes in full face view. Head length (HL) : length from the midpoint of the anterior clypeal border to the midpoint of the occipital border, in full face view. Scape length (SL) : maximum scape length, excluding radicle. Cephalic index (CI) : HW × 100/HL. Scape index (SI) : SL × 100/HW. Specimens were measured with a stereomicroscope under a magnification of 60x. Hair length was measured at 900 × by an optical microscope. A minimum of two workers were measured for every sample, usually up to ten workers if possible. Data are given as means ± S.E. One-way ANOVA was used directly on raw data, without any transformation and, following SEIFERT (1992), a discriminant analysis was done on nest means for European and Japanese samples using STATISTICA 5.5 (StatSoft, Tulsa, Oklahoma, U.S.A.).

Chemical analysis : *Lasius* workers were collected from 3 colonies in Japan (Kyoto, 6-X-1998, T. Akino leg. ; Kyoto, 10-VIII-1999, T. Akino leg. ; Tsukuba, 7-X-2000, T. Akino leg.) and two colonies in Germany (Darmstadt, A. Buschinger leg., no collecting date in a label). From each colony, 10 workers were dissected to separate into three body parts (head, thorax, and gaster), and 5 workers were dissected to excise the mandibular gland from body. Each body part and the gland were separately immersed in 1 ml of hexane for 10 min. One worker equivalent of each extract was used for gas chromatography-mas spectrometry (GC-MS) analyses. The remains were further chromatographed on approximately 1g of silica gel (230-400 mesh, Merck), successively eluted with 3 ml each of hexane, 10 and 30% ether-in-hexane, and ether.

RESULTS AND DISCUSSION

Morphology : for the worker caste, our biometrical measurements show that for a given head length and head width, scapes are proportionately longer in Asian samples (Figs. 1 A, B). The head is proportionately longer in Asian samples (Fig. 1 C). Correspondingly, head indices (Fig. 1 D) are also distinct and statistically different (ANOVA) (Table 1). Length of hairs, as readily noted by WILSON (1955) is longer in Asian samples, specially on the dorsal border of petiole : the longest hair on petiole is longer than half the maximum width of scape (absolute maximum hair length 0.122 ± 0.013 mm). In European samples, hairs are shorter than half the maximum width of scape (absolute maximum hair length 0.085 ± 0.007 mm). In Asian samples, some pronotal hairs are sickle shaped, a striking form that we have not seen in any European sample.

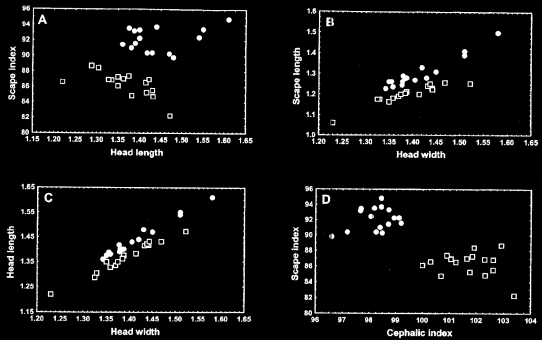

Fig. 1. — Head biometry of *Lasius fuliginosus* (Latreille) (open squares) and *L. nipponensis* Forel (black dots). Points are nest means for a minimum of two workers, maximum of ten workers, per nest. A : Scape index (scape length × 100/head width) as a function of head length (mm). B : Scape length (mm) as a function of head width. C : Head length as a function of head width. D : Cephalic index (head width × 100/head length) and scape index distribution.

Table 1

Measurements on workers and queens of *Lasius fuliginosus* (Latreille) and *Lasius nipponensis* Forel. Figures show mean ± s.d. of nest samples (mm) and range. CI (cephalic index) : HW × 100/HL. SI (scape index) : SL × 100/HW. n : number of nests, number of workers or queens. For each caste, different superscripts indicate statistical difference on nest means (ANOVA) at 0.001 level. N : number of nests, number of specimens measured.

Species	Head width	Head length	Scape length	CI	SI	N
L. fuliginosus workers	1.39 ± 0.06[a] 1.23-1.52	1.36 ± 0.06[a] 1.22-1.47	1.20 ± 0.04[a] 1.06-1.25	101.7 ± 0.9[a] 100.0-103.3	86.3 ± 1.5[a] 82.2-88.6	16,112
L. nipponensis workers	1.41 ± 0.06[a] 1.34-1.58	1.43 ± 0.0[b] 1.36-1.61	1.30 ± 0.07[b] 1.22-1.50	98.2 ± 0.6[b] 96.6-99.1	92.1 ± 1.4[b] 89.8-94.8	16,135
L. fuliginosus queens	1.58 ± 0.04[a] 1.52-1.65	1.50 ± 0.05[a] 1.45-1.60	1.39 ± 0.05[a] 1.35-1.47	105.1 ± 2.1[a] 101.5-106.6	92.5 ±1.9[a] 85.9-93.6	6,7
L. nipponensis queens	1.47 ± 0.02[b] 1.45-1.50	1.43 ± 0.02[b] 1.40-1.51	1.40 ± 0.01[a] 1.37-1.42	102.9 ± 1.1[b] 101.6-105.2	97.5 ± 1.6[b] 93.3-98.2	2,10

Discriminant analysis on nest means allows for an absolute separation of both morphologies. The discriminant function is : D = 3.98 + 82.2 HW - 61.6 HL - 26.3 SL. For Asian samples D varies from -4.77 to -1.51 and for European samples D is 1.22 to 5.48. We need to stress that our measurements on Asian samples are coincident with YAMAUCHI's (1979, Table 4) and KUPYANSKAYA's (1989, table) data ; we remind that Kupyanskaya studied samples mainly from the Soviet Far East Russia and Siberia. Moreover, the direct comparison among Japanese, Korean, and Far East Russian specimens concluded that there is no significant differences in morphology. This indicates that Japanese samples, Korean and Far East Russian samples all belong in the same morphospecies.

For the queen caste, differences go in the same sense as in workers ; specifically, the ground pubescence is much more developed in Japanese samples. Hairiness (erect hairs over the body) both in length and abundance, is stronger in Japanese queens. Absolute size, as measured by head width and length, is smaller in Japanese queens, as was decribed by WILSON (1955) for the Odawara queens. Head proportions are also significantly different (Table 1), with the scape proportionately shorter and the head proportionately wider in European samples.

Males are usually very similar in morphology among the species within the genus *Lasius*. In correspondence with the smaller females, the males of Japanese samples are also smaller in absolute size than those of European samples. The scapes are also proportionately longer in Japanese males (SL/HW behind the eyes : 79.7 ± 2.3) than in European males (75.3 ± 1.8 ; t-test, t = 3.6 ; $p < 0.01$). The differences in pubescence found in female castes are maintained in the males : Japanese males have a much denser pubescence in the gaster than in European males. We have been unable to find consistent differences in any of the many pieces that constitute the genitalia.

Mandibular gland content : from Japanese specimens, two major compounds were found both in the extracts of the mandibular gland and whole bodies. One was dendrolasin (QUILICO *et al.*, 1957), and the other was 3-formyl-7,11-dimethyl-(2E,6Z,10) dodecatrienal (AKINO *et al.*, 1995a). Both compounds were eluted with 10% ether-in hexane from silica gel. In the mandibular gland, the latter compound was approximately 20 times as much as the dendrolasin. Their relative ratio was almost identical in the whole body extract. 3-formyl-7,11-dimethyl-(2E,6Z,10)-dodecatrienal is a strong antifungal and antibacterial compound. (AKINO *et al.*, 1995b). By contrast, only dendrolasin was contained as the major component in the mandibular gland and also in the whole body extract of European specimens. A negligible amount of 3-formyl-7,11-dimethyl-(2E,6Z,10)-dodecatrienal was detected. Such difference in the major gland secretion suggests that the two species have different metabolic systems to synthesize the chemicals. However, this possibility needs to be checked because an alternative source for the compound might be their symbiotic fungi.

Geographical distribution : the species distribution of *L. fuliginosus*, in its present concept, as outlined by WILSON (1955), KUPYANSKAYA (1989), COLLINGWOOD (1979), AGOSTI & COLLINGWOOD (1987), HEINZE & KAUFMANN (1993) and own observations was up to latitude 62° N in southern Fennoscandia to the British Islands and from 40° N at the Iberian Peninsula, Italy, Greece and sparse localities in Turkey, a more southern record from Lebanon and an extreme eastern one from Crimea. Then, an enormous gap is found between Europe and its surrounding area and East Asia, where it is abundant in Japan, Korea and Far East Russia. There remain three enigmatic records that merit consideration and eventual confirmation. BINGHAM (1903) identified *L. fuliginosus* from Thana, Bombay (India) and WILSON (1955) mentioned a single specimen from Tutu River, North Borneo ; this last author expressed doubts about the realiability of both records. In addition, COLLINGWOOD (1982) identified two workers labelled Dharwan, Mysore (India). Those three localities, if confirmed, are remarkably southern in distribution, whichever species they concern, for the genus *Lasius*. In spite of old references by FOREL (1906)

from «Bas Himalaya» and by MENOZZI (1939), there are no confirmed records of *L. fuliginosus* for the Himalayan region.

CONCLUSION

Based on morphological and biochemical arguments we propose to limit the use of the name *Lasius fuliginosus* (Latreille) for the European, Caucasian and Asia Minor populations, and reinstate the species rank of *Lasius nipponensis* Forel for the eastern (Far East Russia, Japan and Korea) populations. A further argument in that direction is that molecular differences of specific degree in DNA sequencing have been also recently found between European and Japanese samples (R. Savolainen, per. com.).

A nomenclatural question comes. KARAVAIEV (1912) described *L. fuliginosus* var. *orientalis* based on Korean material. This taxon was tentatively synonymized by WILSON (1955) under *L. fuliginosus* and this decision was adopted by subsequent authors. From our results, it follows that *L. fuliginosus* var. *orientalis* Karavaiev, should be treated as a synonym of *L. nipponensis* Forel. The publication date of FOREL's paper (3.10.1912) takes priority over KARAVAIEV's (28.12.1912) (WARD *et al.*, 1996).

***Lasius* (*Dendrolasius*) *nipponensis* Forel stat. rev.**

Lasius fuliginosus var. *nipponensis* Forel, 1912 : 339 ; Santschi, 1941 : 278, raised to species ; Wilson, 1955 : 138, including synonymy of *L. fuliginosus* (Latreille).

Lasius fuliginosus var. *orientalis* Karavaiev, 1912 : 586 ; Wilson, 1955 : 138, including synonymy of *L. fuliginosus* (Latreille) **syn. nov.**

The two species can be separated as follows (measures on a minimum of two workers) :

1. Head wider : CI 100.0-103.3 ; scape proportionately shorter : SI 82.2-88.6. Longest hairs on petiolar dorsum < 0.1 mm length. Mesonotal hairs straight. Pubescence on the anterior surface of first gastral tergite and on pronotum diluted, widely spaced with the distance between pubescence as long as or longer than pubescence length ..... *Lasius fuliginosus* (Latreille)

– Head proportionately slender : CI 96.6-99.1 ; scape proportionately longer : SI 89.9-94.8. Longest petiole dorsal hairs > 0.1 mm. Some mesonotal hairs sickle-shaped. Pubescence on the anterior surface of first gastral segment usually much denser, with their interdistances less than the pubescence length ..... *Lasius nipponensis* Forel

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